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Effect of nitrogen and sulphur levels on yield, nutrient use efficiency and economics of safflower (*Carthamus tinctorius* L.) crop

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ABSTRACT

The experiment was carried out during *rabi* season during years 2019-20 and 2020-21 at the Research cum Instructional Farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh. The experiment was laid out in factorial randomized block design with four nitrogen levels and four sulphur levels comprising sixteen treatment combinations with three replications. The soil of the experimental site found neutral to alkaline in reaction (pH 7.13), non-saline (0.21 dS m^{-1}) in nature, medium in organic carbon (5.13 g kg^{-1}), low in available nitrogen (224 kg N ha^{-1}), medium in phosphorus (13.26 kg P2O5 ha^{-1}), high in available potassium (345.19 kg K_2O ha^{-1}), medium available sulphur (21.35 kg S ha^{-1}) and clayey in texture. Applied treatments nitrogen and sulphur levels highest seed yield, stover yield, B:C ratio were recorded with 135 kg N ha^{-1} & 45 kg S ha^{-1}. In applied N and S levels highest NUE 45 kg N ha^{-1} & 45 kg S ha^{-1} and SUE 90 kg N ha^{-1} & 15 kg S ha^{-1} and in lowest was found under control .

Key words: *Safflower economics, Nitrogen and sulphur, Use efficiency, Safflower productivity*

Introduction

Nitrogen is an essential plant nutrient being a component of amino acids, nucleic acids, nucleotides, chlorophyll, enzymes, hormones and promotes rapid plant growth and improves yield attributes through maximum tillering, leaf area, seed formation and protein synthesis etc. and ultimately increases total biomass production, grain yield and its components. Fertilizer nitrogen (N) is believed to have contributed 40% of the growth in per capita food output over the last 50 years. Sulphur is also essential for the formation of chlorophyll and in the formation of vitamins and enzymes required for the plant to conduct its biochemical processes (Jat *et al*., 2017). Sulphur plays an important role in the nutrition of oil seed crop and acts as a constituent of sulphur containing amino acids cysteine, cysteine and methionine (Parmar *et al*., 2018)

In Chhattisgarh, production of safflower crop was 0.11 thousand tons covering an area of 0.27 thousand hectare having average productivity of 405 kg ha^{-1} (GOI, 2018).

Nutrient use efficiencies have been used widely as a measure of the capacity of a plant to acquire and utilize nutrients and may be broken down mechanistically in to the ability to acquire nutrients from the soil (uptake efficiency) and the ability to utilize accumulated nutrients for biomass production or yield formation (use efficiency). In general nutrients requirement and average removal by safflower crop are reported 3.96 kg N, 0.92 kg P &, 6.32 kg K q^{-1} and 20-30 kg N, 5.16-6.45 kg P, 12.45-16.60 kg K and 10-15 kg S $acre^{-1}$ respectively (GOI, 2014 and AICRP-STCR, 2019-20). The use efficiency of applied S is reported normally ranged from 8-12

*SMS, **Dean

percent in different crops

Materials and Methods

The experiment was carried out during Rabi season of 2019-20 & 2020-21 at Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya which is located at $21^0$23'N latitude, $81^0$70' E longitude and 296 m altitude above the mean sea level. This area is situated on NH 6 Zora, Raipur (Chhattisgarh) and carried out with 16 treatments and 3 replications were carried out along with four levels of Nitrogen (0,45, 90& 135) kg/ha and four levels of Sulphur (0, 15,30, 45) kg/ha. Applied seed rate was 20-25 kg/ha, and the basal dose (0:40:30) NPK kg/ha and plot size was 3.5x5.0 m, the plants are spaced at 45x15cm followed by line sowing. pH determine by, Glass electrode pH meter (Piper, 1967). Available nitrogen was determined by Alkaline permanganate method (Subbiah and Asija, 1956), available sulphur was determined by Turbid metric method given by Chesnin and Yien (1951). To carry out chemical analysis of plants, the randomly selected the plants from different plots.

Results and Discussion

N and S use efficiency

The data on N and S use efficiency of safflower as affected by different N and S levels are presented in Table 1.

The mean N and S use efficiency in safflower with applied nitrogen and sulphur levels varied from 62.79-30.70 and 23.24-40.75 percentage and 7.92 to 9.87 and 13.05 to 8.71 percentage respectively. Application of 45 kg N ha^{-1} & 45 kg S ha^{-1} recorded higher NUE and higher SUE recorded as 90 kg N ha^{-1} & 15 kg S ha^{-1} (9.87% and 13.05% kg ha^{-1}) & (62.79% and 40.75%) over their respective treatments . The increase in N and S levels as well as increased the crop yields resulted higher nitrogen use efficiency. Similar results of were found by koutrobas *et al.* (2008), Murtaza *et al.* (2017) and Telebbeigi *et al.* (2018).

B: C Ratio

The B:C ratio of safflower crop influenced significantly with applied nitrogen and sulphur levels over control. The mean B:C ratio in safflower with applied nitrogen and sulphur levels varied from 1.90 to 2.74 and 2.22 to 2.51 respectively. Application of 135 kg N ha^{-1} & 45 kg S ha^{-1} recorded significantly higher B:C ratio as (2.74 and 2.51 kg ha^{-1}) over their respective treatments as shown in Table 1. This might be due to increase in the doses of nitrogen and sulphur that increases in the seed, stalk yield and quality of safflower similar results were found by Nathan *et al.* (2018).

Seed yield (qha^{-1})

The data on Seed yield (kg ha^{-1}) of safflower as affected by different N and S levels are presented in Table 1. The mean seed yield with applied nitrogen and sulphur ranged from 11.76 to 17.89 &13.42 to

Table 1. Effect of nitrogen and sulphur levels on NUE,SUE and B:C ratio of safflower

Nitrogen levels (kg ha^{-1})	NUE (%)	SUE (%)	B:C ratio	Seed yield (q ha^{-1})	Yield increase (%) over control	Stover yield (qha^{-1})	Yield increase (%) over control
N_0	-	7.92	1.90	11.76	-	32.05	-
N_{45}	62.79	7.13	2.18b	13.74	16.84	38.40	19.81
N_{90}	42.68	9.87	2.71a	17.43	48.21	49.75	55.23
N135	30.70	7.42	2.74a	17.89	52.13	51.21	59.78
SEm ±	-	-	-	0.19	-	0.74	-
CD (P=0.05)	-	-	-	0.53	-	2.13	-
Sulphur levels(kgha^{-1})							
S_0	23.24	-	2.22c	13.42	-	36.74	-
S_{15}	33.35	13.05	2.32b	14.51	8.12	40.95	11.46
S_{30}	38.84	10.59	2.50a	16.18	20.57	46.08	25.42
S_{45}	40.75	8.71	2.51a	16.73	24.66	47.66	29.72
SEm ±	-	-	-	0.19	-	0.74	-
CD (P=0.05)	-	-	-	0.53	-	2.13	-

16.73 qha^{-1} respectively. Application of nitrogen & sulphur @ 135 kg ha^{-1} & 45 kg ha^{-1} recorded significantly higher mean seed yields as 17.89&16.73 q ha^{-1}. The lowest seed yields was observed under control. On the basis of mean data, the increase in seed yield with applied @ 135,90 and 45 kg N ha^{-1} were as 52.13%, 48.21% and 16.84% and applied S @ 15, 30 and 45 kg S ha^{-1} was 8.12, 20.56 and 24.66 % compared to the control, respectively. Maximum nutrient availability due to integrated use of N and S fertilizers increased nutrient uptake by the plant which in turn lead to safflower seed yield. Patil *et al*. (2018). These findings are in conformity with the results of Singh and Singh (2013), and Nathan *et al.* (2017).

Stover yield (kg ha^{-1})

The data on Stover yield (kg ha^{-1}) of safflower as affected by different N and S levels are presented in Table 1. Stover yield of safflower crop influenced significantly with applied nitrogen and sulphur levels over control. The mean stover yield with applied nitrogen and sulphur ranged from 32.05 to 51.21 & 36.74 to 47.66 qha^{-1} respectively. The stover yield of safflower differed significantly due to different levels of nitrogen and sulphur levels. Application of 135 kg N ha^{-1} and 45 kg S ha^{-1} was recorded significantly higher mean stover yields as 51.21&47.66 q ha^{-1}. On the basis of mean data, the increase in stover yield with 135, 90 and 45 kg N ha^{1} was 59.78%, 55.23% and 19.81% and 15, 30 and 45 kg S ha^{-1} was 11.46%, 25.42% and 29.72 % compared to the control, respectively. These findings are in conformity with the results of Singh and Singh (2013), and Nathan *et al*. (2017).

Conclusion

The highest seed and stover yield were recorded with 135 kg N ha^{-1} & 45 kg S ha^{-1} and The nitrogen and sulphur applied 45 kg ha^{-1} and 45 kg ha^{-1} showed highest NUE and highest SUE 90 kg N ha^{-1} and 15 kg S ha^{-1}, respectively and lowest in control. The heighest B:C Ratio of safflower was observed due to applied nitrogen and sulphur level @ 135 kg and 45 kg ha^{-1}, respectively and the lowest was found in control.

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